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Effect of high hydrostatic pressure on the color and texture parameters of refrigerated Caiman (*Caiman crocodilus yacare*) tail meat

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ABSTRACT

The effect of applying high hydrostatic pressure (HHP) on the instrumental parameters of color and texture and sensory characteristics of alligator meat were evaluated. Samples of alligator tail meat were sliced, vacuum-packed, pressurized and distributed into four groups: control, treated with 200 MPa/10 min, 300 MPa/10 min and 400 MPa/10 min, then stored at 4 °C ± 1 °C for 45 days. Instrumental color, texture profile and a sensory profiling using quantitative descriptive analysis were carried out on the 1st, 15th, 30th and 45th days of storage. HHP was shown to affect the color and texture of the product, and the sensory descriptors ($p<0.05$). The results suggest that high pressure is a promising technology for the processing of alligator meat, especially low pressures (200 MPa) which can have positive effects on the quality of the product.

1. Introduction

The breeding of caiman (*Caiman crocodilus yacare*) has been developing over the years in Brazil, thus representing an economically promising activity, especially in the Pantanal (swampland) region. Historically this activity has been related to manufacture of leather, but more recently the meat has been commercialized in specialized restaurants, with good acceptance (Vicente Neto et al., 2007).

As a consequence of market globalization, industry is searching for means to increase productivity and improve product quality, and thus new technologies are being developed and/or improved (Ferreira, Masson, & Rosenthal, 2008). High hydrostatic pressure (HHP) is a technology which is non-thermal, and consists of submitting the foods to pressures above 100 MPa (Cruz et al., 2010). This technology preserves the quality without significant alterations of the food matrix, with the advantage of efficiently eliminating microorganisms, providing microbiological safety and increased shelf life (Mathias et al., 2010). It has been used with success for meat products from different animal species (Aymerich, Picouet, & Monfort, 2008; Gou, Lee, & Ahn, 2010; Souza et al., 2011).

Among the adverse effects of high pressure, are alterations in color and texture, due to structural changes in macromolecules such as proteins. The covalent protein bonds are little affected by high pressure, but hydrophobic and electrostatic bonds can be affected, causing significant conformational changes and affecting functionality, frequently irreversibly, depending on the nature of the protein and the pressure applied (Lamballerie-Anton, Taylor, & Culioli, 2002). These attributes are important quality parameters and directly influence the consumer (Fletcher, Qiao, & Smith, 2000).

The application of preservation methods to alligator meat is a recent innovation (Vieira, 2010), but there are no available studies on the application of high hydrostatic pressure to this meat. Thus the objective of this study was to evaluate the effect of HHP on the quality parameters and sensory characteristics of alligator tail meat.

2. Material and methods

2.1. Sampling

Tail samples from 24 caiman (*Caiman crocodilus yacare*) were used, the caiman were reared in captivity to approximately 2.5 years of age, chosen at random and humanely slaughtered (Brasil, 2000) at the abattoir of the Swampland Alligator Breeder Cooperative (SIF 2452) in the city of Cáceres, State of Mato Grosso, Brazil. The 24 carcasses were cooled, the tails deboned and vacuum-packed (Criovac©), and

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transported to the Sensory Analysis Laboratory (UFF, Rio de Janeiro, Brazil) in isothermal boxes containing broken ice. They were then removed from the vacuum packs, cut into 25 g portions, packed into sterile plastic bags (10×4 cm), and transported in isothermal boxes containing ice to Embrapa Food Agro-industry – RJ, Brazil, where they were vacuum packed (gas-run, model 30 from Engevac©) and maintained at 4 °C± 1 °C until pressurized.

2.2. Experimental design

Twenty-four alligator tails were vacuum-packed and divided into four groups each with six tails. Each group was divided at random into 25 g portions, giving a total of 20 samples per group, which were further divided into 4 sub-groups of 5 samples each (repetitions), submitted to the proposed treatments, and analyzed after four storage periods (1, 5, 30 and 45 days), giving a total of 80 sample units. The operational conditions for each treatment and the respective codes were control (CON), 200 (P200), 300 (P300) and 400 (P400) MPa pressure treatments for 10 min.

2.3. High hydrostatic pressure

The pilot equipment *Stansted Fluid Power* — model S-FL-850-9-W was used for pressurization. The pressure level was adjusted (200, 300 and 400 MPa) and the time of 10 min was controlled manually, maintaining the operational temperature at 20 °C. The come-up rate was approximately 300 MPa/min and total decompression took about 30 s. The samples were introduced into the stainless steel perforated cylinder of the equipment, whose dimensions were approx. 7.0 cm in diameter and 20.0 cm in length, using 70% alcohol as the pressure-transmission medium. After hermetically closing the chamber containing the cylinder, two pneumatic pumps were sequentially switched on to raise the pressure to the desired conditions. At the end of the cycle, the chamber was depressurized and opened to remove the samples.

2.4. Instrumental color analysis

The color parameters of L* (luminosity), a* (−a = green; +a = red) and b* (−b = blue; +b = yellow) were obtained using a portable Konica Minolta model CR 400 colorimeter (Konica Minolta Sensing, Inc., Osaka, Japan). For the reading, the *in natura* samples were transversally cut (thickness of 1 cm) and maintained at room temperature for 30 min. The result was obtained from the mean of measurements made at three distinct regions of each sample.

2.5. Instrumental texture analysis

The texture analysis was carried out through texture profile analysis (TPA) (Bourne, 1978) under the following conditions: *in natura* samples cut into 1 cm^3 cubes at a temperature of 10 °C, model TA-Hdi texturometer (Stable Micro System, London, England) with a 36 mm diameter cylindrical metal probe (P/36R), compression to 50% of the original height in two cycles, pre-test speed: 3.00 mm/s; test speed: 1 mm/s; and post-test speed: 3 mm/s, time between compressions: 2 s, and 100 g of force per area. The data were processed the Texture Expert for Windows (R, Stable Micro System), to give the cohesiveness, hardness, springiness and resistance. Ten repetitions were made for each group on each sampling day.

2.6. Sensory profiling

The sensory profile of each product was determined by eight selected and trained assessors, regular consumers of meat products, using the quantitative descriptive analysis method (QDA) developed by Stone, Sidel, Oliver, Woosley, and Singleton (1974). This analysis was carried out using cooked and raw samples after 1, 15, 30 and 45 days storage at 4 °C. For the QDA, control and pressurized at 200, 300 and 400 MPa samples were cooked by immersion in water until the geometric center reached approximately 70 °C, which was monitored by digital thermometer. After cooking the samples were cut into 1 cm^3 cubes and presented to the assessors.

The assessors were recruited with the aid of an individual oral interview amongst students already trained and used to this type of sensory analysis. The panel had already carried out this type of analysis and therefore had experience in the type of evaluation. Ten assessors took part in the test (five men and five women aged between 25 and 39), students of the postgraduate program in Veterinary Hygiene and Technological Processing of food of the Fluminense Federal University, previously orientated and trained in the analysis of control and pressurized samples.

During training of the sensory panel, the samples were offered to the assessors and the attributes of appearance, aroma, flavor and texture determined from an open discussion amongst the panel members, moderated by a leader. After determining the attributes, the panel met for a further six 2-hour sessions to establish, by consensus, the definitions and references for the subsequent elaboration of the scorecard. After identification of the attributes and definition of the references, training with the descriptive terms was carried out with anchor points of “slight” or “a lot” for each attribute evaluated. Before carrying out the QDA, the performance of the panel was evaluated, verifying their discrimination between samples, repeatability and agreement amongst the members (Damásio & Costell, 1991). Analysis of variance (ANOVA) was used for this purpose, with two causes of variation (sample and repetition) for each attribute and assessors, selecting those assessors with significant F sample values ($p<0.30$) and non-significant F repetition values ($p>0.05$). The eight assessors selected (three men and five women) took part in the subsequent tests. Four repetitions were used per treatment (control and pressurized sample) of the alligator tail meat and the samples were served in a monadic way, coded with three-algorism numbers and with a balanced presentation order.

For the final evaluation of all the attributes the samples were presented at room temperature on disposable white plastic plates under white light in individual booths. Salted bread and mineral water at room temperature were offered to clean the palate between samples. The trained panel carried out the QDA of the samples under laboratory conditions with five repetitions per assessor, using a scorecard with a non-structured 15 cm-long perception intensity scale.

2.7. Statistical analysis

A 4×4 factorial analysis of variance was carried out according to the pressure level (control, 200, 300 and 400 MPa), days of storage (1, 15, 30 and 45) and the interaction between the variables. Results showing a significant effect of pressure and/or storage were tested by ANOVA according to a completely random design for time and pressure level separately, followed by Tukey test ($p<0.05$). The software “Statistical Analysis System” (SAS, 2000) was used to carry out these analyses.

The results of the quantitative descriptive analysis were evaluated by principal components analysis in a correlation matrix with the data centered on the mean. A matrix was elaborated with 4 lines and 5 columns, the lines representing the samples, and the columns the sensory descriptors. Hieraquical Clustering Analysis (HCA, Souza et al., 2011) was also carried out with the objective of evaluating the separation of the samples with respect to the QDA attributes. The clustering parameters were: dissimilarity, Euclidean distance, agglomeration method, Ward's method and manual truncation. Finally the parameters involved in the instrumental analyses of color and texture profile were related through Pearson's correlation. All these analyses were carried out using the software XLSTAT for Windows 2010.